A Survey - Energy Efficient Routing Protocol for Wireless Sensor Network

*** Jyoti Choyal**
**** Shivangini Morya**

ABSTRACT

Wireless sensor networks have recently emerged as an important computing platform. These sensors are power-limited and have limited computing resources. Therefore, the sensor energy has to be managed wisely in order to maximize the lifetime of the network. There have was many studies on considering sensor's energy. Among these, clustering sensor nodes is a more efficient and adaptive approach in sensor networks having some essential requirements. First, every node in a cluster should elect one cluster head. Second, clustering must minimize overhead. Third, network topology must be stable. Finally, as sensor nodes are operated; low power, low energy consumption is required.

Keywords: - Energy Efficient routing, Leach, Pegasis and WSN.

* Jyoti Choyal, Research Scholar, Sagar Institue of Research and Technology Indore, choyaljyoti@gmail.com
** Shivangini Morya, Asssistant Professor, Sagar Institue of Research and Technology Indore, enggshivangini2006@yahoo.co.in

I. INTRODUCTION

In recent years wireless sensor networks has been a new and hot domain in computer science and technology and has a wide application future. It has enabled the development ofa sensor node with a low-cost processor, low power, and light weight [1]. The wireless sensor networks consist of small sensor nodes able to detect light, sound, temperature, motion, an intelligent computing device that enables the processing of data collected from sensors and communication capabilities with other nodes through wireless networks. Sensor nodes can self-organize to form networks and communicate with each other using their wireless interfaces and transmit to the destination as multi-hop. In large-scale sensor networks, hundreds or thousands of sensor nodes are randomly deployed into a sensing field.

Sensor nodes are especially useful in extremely hostile environments, such as near active area, inside a dangerous chemical plant, or in disaster areas with a nuclear reactor. In addition, potential applications for such large-scale wireless sensor network (WSN) exit in a variety of fields, includes environmental monitoring, surveillance, health-care monitoring and military operations as shown in Figure 1. Also, motivated by the emergence of ubiquitous computing technology [1] as the next generation of computing, a new class of network robots has been introduced. It is a concept that provides the services for person, anytime, anywhere. Since it is inherently based on ubiquitous environments with networked sensors and actuators, it can be considered as one of the

most important emerging applications of wireless sensor networks. Distributed networks which consist of sensors to perceive and send data measured in the surrounding environments are developed to reposition and organize sensor nodes to acquire and deliver the corresponding information [5]. To make wireless sensor networks apply to various applications, efficient design and implementation of wireless sensor networks is required.

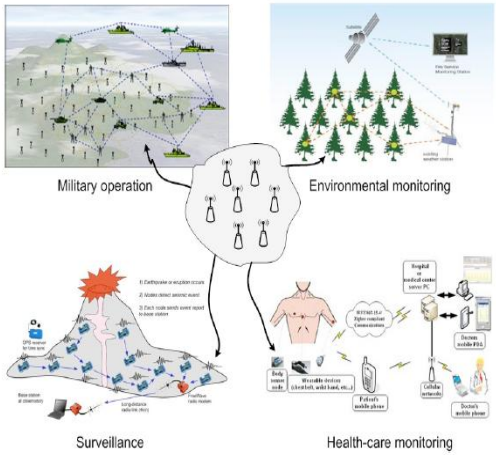

Figure 1: Application of wireless sensor networks

Wireless sensor network:- WSN is a very large array of diverse sensor nodes that are interconnected by a communication network. The sensing data are shared between the sensor nodes and are used as input for a distributed estimation system. The fundamental objectives for WSN are reliability, accuracy, edibility, cost effectiveness, and ease of deployment. WSN is made up of individual multifunctional sensor nodes. Figure 2 shows the communication architecture in WSN. The sensor nodes are usually scattered in a sensing field. Each scattered sensor node has the capability to collect data and route collected data to the sink by multi-hop architecture. The sink may communicate with the task manage node via Internet. The design of WSN is influenced by many factors, including fault tolerance, scalability, production costs, operating environment, sensor network topology, hardware constraints, transmission media, and power consumption [1].

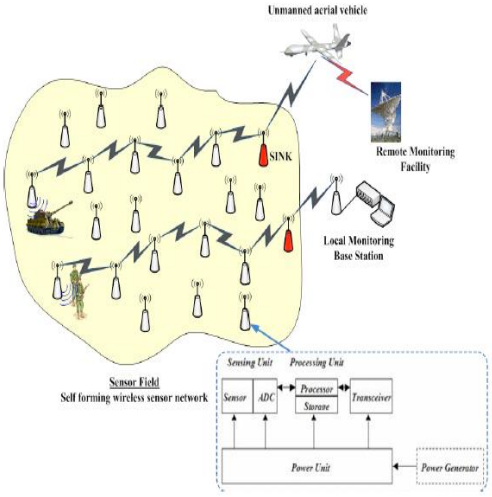

Figure 2: Organization of communication in the sensor networks

The components of a sensor node such as location finding system, mobilize, and power generator may also be present. The sensor node senses the physical quantity being measured and coverts it into an electrical signal. (refer to Figure 2) Then, the signal is fed to an A/D converter and is ready to be used by the processor. The processor will convert the signal into data depending on how it is programmed and it sends the information to the network by using a transceiver. The power unit may be supported by solar cells or battery.

These sensor nodes operate in an ad-hoc manner and they have specific features. The design for all protocols focuses on the extension of network lifetime, since sensor nodes havea limited amount of energy. The implicit operations of WSN are a variety of information processing techniques. These are used for the manipulation and analysis of sensing data, the extraction of significant features, and the efficient storage and transmission of important information. The protocol and algorithms that have been proposed for traditional wireless ad-hoc networks are not well suited to the requirements of WSN [11].

The specific characteristics of WSN are as follows:

- Sensor nodes are limited in power, computational capacities, and memory.
- Sensor nodes are densely deployed.
- The number of sensor nodes will be much more than the number of nodes in ad-hoc network.
- Sensor nodes may not have global identification because of the large number of sensors.
- Sensor nodes mainly use broadcast communication paradigms whereas most ad-hoc networks are based on point-to-point communications.

II. LITERATURE REVIEW

Researchers proposed variety of technology to reduce energy consumption in WSN. A number of techniques have been proposed on energy efficient routing protocols. A survey of these techniques is given in this section.

Mohsin Raza Jafri et al. [7] recommended a multi-chain model of PEGASIS along with induction of sink mobility to maximize the network lifetime in this paper. Their considerations are supportive in diminishing the delay in data delivery and distances between the connected nodes through shorter chains. Sink mobility not only decreases load on the chain leaders in opening rounds, but also shorten the stress on unused nodes at the end of network lifetime. They also propose an algorithm for fixed path sink mobility in their design. Sink mobility has major gain on static sink in enhancing the network lifetime.

OuadoudiZytoune et al. [8] presented a new algorithm for gathering the data in WSN based on chain forming using greedy algorithm. It targets on equally circulate the energy load over the whole network nodes. To advert fast node dying, the leader role is better distributed over nodes. It is based on their required energies to transmit to the sink. Thus, the unified network nodes would have the same lifetime and then as result, the network lifetime would be protracted. The proposed technique allows balancing the transmission energy correctly over the whole network nodes, which leads to network lifetime extension. The simulation results show the improvement provided by this technique compared to the well-known protocol for chaining in wireless sensor networks.

Samia A. Ali et al. [9] proposed an efficient routing protocol called CCBRP (Chain-Chain based routing protocol). It achieves both minimum energy consumption and minimum delay. The CCBRP protocol mainly divides a WSN into a number of chains using Greedy algorithm and runs in two steps. In the first step, sensor nodes in each chain transmit data to their chain leader nodes in parallel. In the second step, all chain leader nodes form a chain and randomly choose a leader node then all nodes send their data to this chosen leader node. This chosen leader node fuses the data and forwards it to Base Station (BS). Experimental results demonstrate that the energy consumption of the proposed CCBRP is almost as same as for PEGASIS and 60% less than LEACH and 10% less than CCM for WSN with hundred nodes distributed in 100m x 100m area. The delay of the proposed CCBRP is the same as of LEACH and CCM but 75% less than of PEGASIS.

Tarun Gulati et. al. [10] proposed this paper on node reliability in Wireless sensor network. Each sensor is defined with limited energy. Wireless sensor node utilized into the network to monitor the physical or environmental condition such as temperature, sound, vibration at distinct location.

The protocol play significant roll, which decreases the delay while offering high energy efficiency and long span of network endurance. One of such protocol is PEGASIS, it is placed on the chain architecture, every chain have only one cluster head, this cluster head is in charge with every note's receiving and sending messages who reside to this chain, the cluster head depleted large energy and the times of every round growing. In PEGASIS, it takes the advantage of sending data to it the closet neighbor, it save the battery for WSN and growing the period of the network. The proposed work in this paper is about to select the next neighboring node reliably.

III. ROUTING IN WIRELESS SENSOR NETWORK

Despite the many applications of wireless sensor networks, these networks have many restrictions, for example, limited energy, limited communication range etc. One of the main design goals of wireless sensor networks is to complete data communication while trying to extend the lifetime and keep the quality of communication. The design of routing protocols in wireless sensor networks is affected by many challenging factors. Because a distributed network has a lot of sensor nodes and each node is a shared resource, many decisions must be made. There may be many paths from the source to the destination so the routing path is an important topic [11]. First of all, routing models are explained and problems that can occur when applied to sensor networks are examined.

Routing model: - It is the simplest model of all in which sensor node directly communicates with BS (Base Station), as seen in Figure 3. Sensor nodes have a restricted transmission range. Thus, this model is not proper for wireless sensor networks, in which the energy of sensor node is an important resource. When there is a close distance between node and base station, this model may be the most appropriate model for sensor networks. However, in most sensor networks, the sensor nodes are randomly distributed in abroad area and then perform sensing. Thus, this model is not suitable for sensor network. Also, even if sensors are close to the BS, the collision occurs on dense networks [7].

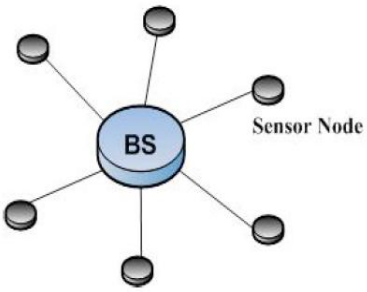

Figure 3: One-hop protocol model

Multi-hop model: - In this model nodes send data to the neighboring node close to BS. Consequently the data moves from one node to another node with hop unit until it reaches its destination (See Figure 4). However, in the networks where the number of sensor nodes reaches thousands of pieces, the multi-hop model indicates very high latency. Another vulnerability, which may appear in this model, is the effect of black hole. In other words, it is suggested that the closer node to BS needs to play an intermediary role in data toward BS. Accordingly, such nodes form a black hole around BS, and consume energy more quickly than other nodes. When trying to consider energy; even this model cannot become a proper model for sensor networks [7].

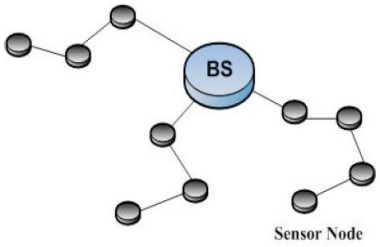

Figure 4: Multihop protocol model

Cluster-based model: - In cluster-based model, the nodes are grouped in clusters. There is a cluster head in each cluster which plays a role of routing data into other clusters or base stations by gathering datafrom nodes within its cluster. In this model, data is first gathered within each cluster and then it follows a method which delivers the data to other clusters or base stations. In Multi-hop based model, all the relay nodes perform data aggregation. On the other hand, in cluster-based model, only cluster head performs data aggregation. Accordingly, cluster-based model can be a model that is more proper for WSN than multi-hop network. In this protocol

model, the cluster is formed statically. If the cluster is fixed, a problem of black-hole can occur as in multi-hop. Namely, the node, which is the closest to cluster head, not only senses itself, but also plays a role of delivering it to cluster head by receiving data in other node. Thus, such nodes will shorten relative lifetime

IV. PROBLEM FORMULATION

The residual energy at a node in the sensor network is a significant parameter for cluster heads. In this thesis, both of the LEACH and PEGASIS harnessed the residual energy of the node so as to extend lifetime of the sensor network, but both of them were not free from the following problems.

LEACH use a random method with a self-organizing clustering based protocol to evenly distribute energy loads between each sensor, coincidently electing CH with a probability. For selecting CHs, each sensor choose a random number between 0 and 1 inclusive.

Network model key features: - The key features of scheme are listed in the followings:

- Sensor network consists of a cluster
- CHs that supply the energy continuously are present in each cluster
- CHs know the location of sensor node and ID
- All except the CH sensor nodes are homogeneous properties and their energy is limited
- CHs can communicate directly with each node within the same cluster
- Each sensor node knows the initial energy and residual energy
- A Round consists Set-up phase and Steady-state-phase
- Cluster Head features
    - It has more computational power than sensor nodes
    - Long-distance communication capabilities to communicate with other cluster heads and can communicate with BS
    - One per cluster exists

V. CONCLUSION

This work studied routing protocol for increasing lifetime of network by efficiently managing sensor-node energy based on clustering. In wireless sensor network, as LEACH protocol is a typical clustering protocol, it consumes energy efficiently by forming cluster. However, it fails to efficiently compare nodes' energy in the clustering phase, and thus results in forming bad-case scenario, thereby failing to extend network lifetime more lengthily. Accordingly, this thesis

applied CH selection threshold by comparing the energy in the current round and the energy in the previous round by using the existing LEACH routing, and allowed CH probability to be compensated, thereby providing a change in the whole threshold value.

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